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(71) Applicant *(for all designated States except US)*: **HIGH TECH APPLICATIONS HOLDINGS LIMITED** [CY/CY]; 12, Kypranoros Street, 1061 Nicosia (CY).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **WIJNEN, Arie, Marinus** [NL/GB]; 94 Goshawk Gardens, Hayes, Middlesex UB4 8LB (GB).

(74) Agent: **VAN DER AREND, A., G., A.**; Exter Polak & Charlouis B.V., P.O. Box 3241, NL-2280 GE Rijswijk (NL).

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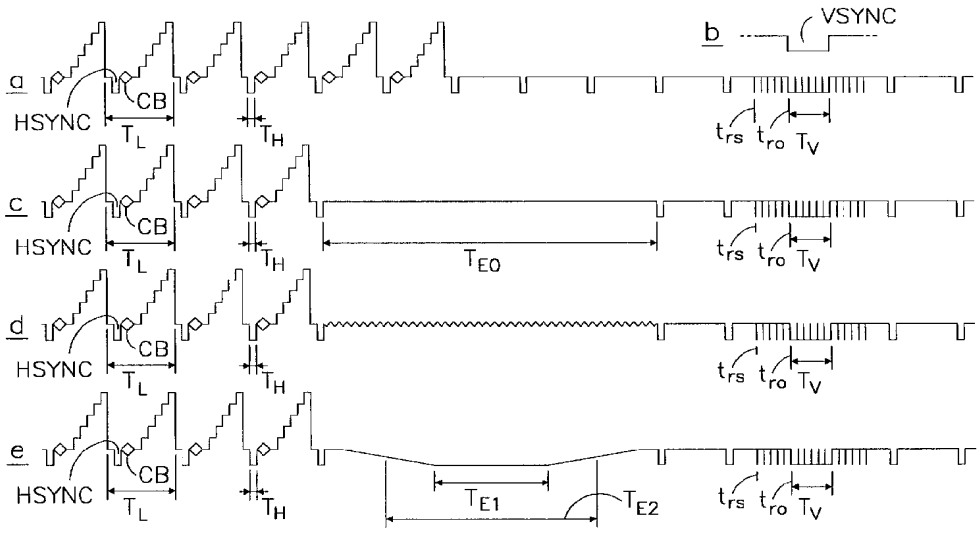
(54) Title: METHOD AND APPARATUS FOR PROCESSING A VIDEO SIGNAL FOR ATTAINING COPY PROTECTION, A VIDEO SIGNAL OBTAINED THEREWITH AND THE USE THEREOF



(57) Abstract: Method and apparatus for processing an input video signal (Figure 2a) with protection against unauthorized reproduction thereof by means of substantial smoothing, around raster transitions of the input video signal and during a smoothing period (T_{EO}) of variable duration, of the input video signal so as to provide an output video signal (Figure 2c) which is suitable for display thereof by a display apparatus (10), but whose smoothed segments after registration and reproduction by a registration apparatus (11) will, when displayed by the display apparatus (10), lead to incorrect raster synchronization.

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Method and apparatus for processing a video signal for attaining copy protection, a video signal obtained therewith and the use thereof.

The invention relates to a method for processing an input video signal which represents a picture to be displayed by a video display apparatus and which comprises successive rasters, separated by raster synchronization pulses, of scanning lines separated by line synchronization pulses, so as to provide an output video signal.

A method of this type is generally known, for example for decoding and/or amplifying the input video signal.

It is an object of the invention to provide such protection against copying of the input video signal that the input video signal after registration and reproduction by a registration apparatus produces a poor picture on the display apparatus. The registration apparatus is in particular a apparatus such as an analog video recorder which is not capable of faithful registration and reproduction of long-duration a D.C. signal.

To achieve said object, said method according to the invention is characterized in that at the ends of the rasters different numbers of scanning lines and associated line synchronization pulses are substantially smoothed. During registration of such an output signal, the smoothed segments will drop to a level used for the detection of the raster synchronization pulses (or vertical synchronization pulses). As a result, the display apparatus will, during reproduction of the video signal containing smoothed segments from the registration apparatus, detect raster synchronization pulses at incorrect times, causing continuous vertical jumping of the displayed picture, making it difficult to observe the picture, thereby rendering registration and reproduction of the video signal comprising the smoothed segments useless for practical purposes.

The invention also provides an apparatus suitable for implementing the method according to the invention, in particular a video signal processing apparatus according to claim 9.

The invention further relates to a video signal according to claim 15 obtained by means of the method or apparatus, or to a video

signal obtained after registration and reproduction thereof, according to claim 21.

The invention further relates to the use of an apparatus according to the invention and to the use of a video signal obtained by means of the method or the apparatus according to the invention.

The invention is explained below with reference to the accompanying drawings in which:

Figure 1 shows a block diagram of a set up comprising a video signal processing apparatus in which the invention is implemented; and

Figures 2a-e show time diagrams of signal wave shapes which can occur in the video signal processing apparatus of Figure 1.

Figure 1 shows an example of a video signal processing apparatus 1 in which the invention is implemented. The video signal processing apparatus for example is a satellite receiver which is connected to a parabolic antenna 2 which feeds an antenna signal to a receiver 3 of the video signal processing apparatus 1. The receiver 3 demodulates and amplifies the received signal. Alternatively, the receiver 3 is suitable for being connected to a cable of a central antenna arrangement.

The signal received by the receiver 3 generally comprises a number of video channels, one or more of which are television subscriber channels which can be used only by a paying subscriber. For these television subscriber channels, the video signal processing apparatus 1 comprises a decoder 4 which has the purpose, depending on an authorization feature received from the user of the apparatus, e.g. by means of a chip card (not shown), of decoding or transmitting the television subscriber channel desired by the user as an output signal of the decoder 4.

In known video signal processing apparatuses, the output signal of the decoder 4, generally after modulation of a carrier and addition of the signal received by the antenna 2 or cable, is delivered as an output signal of the video signal processing apparatus 1 so as to be suitable for selection and display by a display apparatus 10, which in general is a television set. Such a signal is however also suitable for being recorded by a registration apparatus 11, in particular a magnetic tape apparatus, and subsequently to be reproduced and displayed, either by the same user

or somebody else. This poses the risk of unauthorized registration and distribution of video signals for which payment was due.

Since a video signal delivered to a display apparatus 10 must be suitable for being displayed by the display apparatus 10, no suitable options have existed until now for preventing this signal from being recorded for subsequent reproduction and correct display at a later time.

The invention provides a method and an improved video signal processing apparatus by which the production of usable illegal copies of a received video input signal by means of a registration apparatus 11 is prevented. This will be explained in conjunction with Figure 2.

Figure 2a shows a segment of a normal video signal not modulated on a carrier. This signal is hereinafter referred to as input video signal and can consist of the output signal of the decoder 4.

The input video signal consists of successive rasters, separated by raster synchronization pulses (or vertical synchronization pulses), of scanning lines separated by line synchronization pulses (or horizontal synchronization pulses). Depending on the television system, e.g. PAL and NTSC, interlaced scanning lines of two successive rasters at a time generally form a rectangular raster area of which a smaller rectangular section forms a picture area of a visible picture.

Each scanning line has a duration T_L and successively consists of a front porch, a horizontal synchronization pulse HSYNC, a back porch and a picture information portion. In a colour television system, the back porch is superimposed by a burst CB of a chrominance subcarrier. The stepped shape, shown in Figure 2, of the picture information merely serves as an example and to indicate the amplitude relations.

At the end of each raster, the display apparatus from a time t_{rs} suppresses the display of the picture during a time which is longer than the time of a relatively large number of scanning lines, e.g. 25 scanning lines plus 12 μs in the PAL system. The start of each raster is indicated in Figure 2 by the time t_{r0} which, in the PAL system, follows t_{rs} after an interval corresponding to 2.5 scanning lines. From the start time t_{r0} of a raster, the video signal substantially has a constant low level over a period T_V. This period

T_V in the PAL system has a duration corresponding to 2.5 scanning lines. Integrating the video signal for some time around the raster starting time t_{r0} provides a signal which over the period T_V substantially has a low level and outside this period has a high level. While the duration T_H of a line synchronization pulse HSYNC is relatively short, being 4.7 μs in the PAL system, the period T_V is relatively long, being 160 μs in the PAL system. This allows the period T_V of the video signal to be clearly distinguished from the line synchronization pulses and to be used for synchronization of the rasters of the picture.

Figure 2b (top right hand of Figure 2) shows a segment of a raster synchronization signal, obtained by said integration and comprising raster synchronization pulses VSYNC.

According to the invention, during the time of a number of scanning lines at an end (i.e. at the start or at the end or at the start and the end of each picture), the video signal is smoothed, e.g. as far as the level of the front and back porches, thus affording, for example, a signal as depicted in Figure 2c with smoothing over a period T_{E0} at the end of a raster.

The video output signal of Figure 2c, obtained by the smoothing of the video signal of Figure 2a, is suitable for being displayed by the display apparatus 10 in a normal manner, retaining the visible picture area. Preferably, the smoothing period T_{E0} has a duration equal to that of from 3 to 12 scanning lines.

However, if the video output signal of Figure 2c is recorded by a registration apparatus 11, particularly a magnetic tape recorder, the smoothed segment will be represented on the registration medium as a signal part having a level which, over a significant segment, e.g. the segment T_{E1} shown in Figure 2e, is equal to the lowest level of the video signal. If the video signal of Figure 2e is reproduced by the video registration apparatus 11, the display apparatus 10 will detect as a raster synchronization pulse a segment T_{E2} which extends on both sides past the period T_{E1}. As a result of the configuration of the raster synchronization circuit of general television sets as a display apparatus 10, the display apparatus 10 will synchronize rasters during the incorrectly reproduced period T_{E2}, but will not do so during the normal synchronization period T_V following shortly afterwards. As a result, the raster following the

period T_{E2} will be displayed by the display apparatus 10 from an incorrect time or an incorrect location in said raster area.

If the period T_{E2} of the output video signal shown in Figure 2e is not the same for different rasters, the displayed picture will jump, depending on the differences in T_{E2}, with the result that the user is presented with a poor picture and the operation of registration the processed video output signal according to Figure 2c and consequently also that of copying and duplicating it will prove to have been futile.

A choice of various options is possible for varying the period T_{E2} of the video output signal of Figure 2e which is detected by the display apparatus 10 as a raster synchronization pulse. A number of options will be explained below.

Said smoothing of the video input signal as shown in Figure 2a at one end or both ends of the rasters can be alternately carried out or not carried out for each raster.

The actual smoothing can be effected by a separate physical electronic circuit. Since a video signal processing apparatus 1 of the type comprising a decoder 4 is already equipped with data processing means, said smoothing can also be carried out on a software basis by means of these data processing means or alternatively via additional data processing means. Since various solutions to the smoothing operations are possible, the means therefor are generally indicated in Figure 1 by smoothing means 15.

Said smoothing or non-smoothing of end sections of rasters can be applied to successive groups of rasters, the numbers of the rasters for the respective groups being preferably randomly generated afresh each time. Suitable for this purpose is a hardware-based or software-based random number generator 16 which, in accordance with Figure 1, is connected to the smoothing means 15.

In addition, the duration T_{E0} of the end section of rasters over which smoothing is carried out can be a time randomly determined afresh on each occasion, in particular a random number of scanning lines and associated line synchronization pulses. This allows the use of the random line number generator 17 shown in Figure 1 and connected to the smoothing means 15.

The interference effect caused by the smoothing of end sections of rasters of the video signal can be enhanced if the video signal is modulated, e.g. by means of a fixed-frequency modulation signal,

over at least part of the periods T_{E0} over which smoothing is carried out, as shown in Figure 2d. To prevent the modulated smoothed segment from interfering with the display of the video signal of Figure 2d by the display apparatus 10, the amplitude of the modulation signal is preferably smaller than the amplitude of the burst CB of the chrominance subcarrier signal. It is found that the frequency range of the modulation signal can be large. Preferably, a range of between 100 kHz and 20 MHz is used.

As the modulation signal can have a relatively wide frequency range, frequency modulation can be employed during the period T_{E0}, and various signal wave shapes, including triangular wave shapes and rectangular wave shapes can be employed. The use of these can further enhance the interference effect of the smoothing and said modulation according to the invention on the raster synchronization by the display apparatus 10. Such a modulation signal can be generated by means of an oscillator 18 connected, in Figure 1, to the smoothing means 15.

It should be noted that where the description and the claims refer to the smoothing of different numbers of scanning lines and associated line synchronization pulses, this is not restricted to smoothing over necessarily integer numbers of scanning lines and associated line synchronization pulses nor to uninterrupted smoothing over said scanning lines and line synchronization pulses or segments thereof. The main point is that a smoothed segment of a video signal after registration and reproduction thereof by a registration apparatus 11 has a shape which, as a result of the action, generally based on an integrator, of a raster synchronization circuit of the display apparatus 10, is detected as a raster synchronization pulse and that this does not happen if the display apparatus 10 receives the output signal of the smoothing means 15 either directly or via a standard bypass circuit of the registration apparatus 11.

CLAIMS

1. Method for processing an input video signal which represents a picture to be displayed by a video display apparatus (10) and which comprises successive rasters, separated by raster synchronization pulses, of scanning lines separated by line synchronization pulses, so as to provide an output video signal, **characterized** in that around raster transitions during a smoothing period (T_{E0}) the input video signal is substantially smoothed, the duration of the smoothing period being varied for different raster transitions and comprising a number of scanning lines and associated line synchronization pulses.

2. Method according to claim 1, **characterized** in that smoothing is alternately carried out and not carried out for successive groups of rasters.

3. Method according to claim 2, **characterized** in that the number of rasters of different groups of rasters is an individual random number.

4. Method according to any preceding claim, **characterized** in that the number of scanning lines and associated line raster synchronization pulses of the smoothing period (T_{E0}) is from 3 to 12.

5. Method according to any one of claims 1-3, **characterized** in that the number of scanning lines and associated line synchronization pulses of the smoothing period (T_{E0}) for different rasters is an individual random number.

6. Method according to any preceding claim, **characterized** in that during the smoothing period the input video signal is modulated by such a modulation signal, that after registration and reproduction of the output video signal by a registration apparatus, the reproduced video signal during the smoothing period (T_{E2}) thereof substantially has an amplitude like that of the line synchronization pulses.

7. Method according to claim 6, **characterized** in that the amplitude of the modulation signal is smaller than the amplitude of a chrominance subcarrier burst of the output video signal.

8. Method according to claim 6 or 7, **characterized** in that the frequency of the modulation signal is between 100 kHz and 20 MHz.

9. Apparatus for processing an input video signal which represents a picture to be displayed by a video display apparatus (10) and which comprises successive rasters, separated by raster synchronization pulses, of scanning lines separated by line synchronization pulses, so as to provide an output video signal, **characterized by** smoothing means (15) which, around raster transitions, substantially smooth the input video signal during a smoothing period (T_{E0}) having a duration which varies for different raster transitions and comprises a number of scanning lines and associated line synchronization pulses.

10. Apparatus according to claim 9, **characterized by** a random raster number generator (16) which drives the smoothing means (15) so as to apply different smoothing periods (T_{E0}) during successive groups of different random numbers of rasters.

11. Apparatus according to claim 9 or 10, **characterized by** a random line number generator (17) which drives the smoothing means (15) so as to apply, for successive raster transitions, smoothing periods (T_{E0}) comprising random numbers of scanning lines and associated line synchronization pulses.

12. Apparatus according to any one of claims 9 to 11 inclusive, **characterized by** an oscillator (18) which drives the smoothing means (15) so as to modulate the smoothed input video signal during the smoothing period (T_{E0}) with a modulation signal whose frequency and amplitude are such that after registration and reproduction of the output video signal by a registration apparatus, the reproduced video signal during the smoothing period (T_{E2}) thereof substantially has an amplitude like that of the line synchronization pulses.

13. Apparatus according to claim 12, **characterized** in that the amplitude of the modulation signal is smaller than the amplitude of a chrominance subcarrier burst of the output video signal.

14. Apparatus according to claim 12 or 13, **characterized** in that the frequency of the modulation signal is between 100 kHz and 20 MHz.

15. Video signal, comprising rasters, separated by raster synchronization pulses, of scanning lines separated by line synchronization pulses, **characterized** in that, around raster transitions during a smoothing period (T_{E0}), of which a duration comprises a number of scanning lines and associated line synchronization pulses, no line synchronization pulses are present and the duration of the smoothing period (T_{E0}) varies.

16. Video signal according to claim 15, **characterized** in that the smoothing period (T_{E0}) varies for successive groups each comprising a random number of rasters.

17. Video signal according to claim 15 or 16, **characterized** in that the smoothing period (T_{E0}) for successive rasters has a duration, for each raster, of a random number of scanning lines and associated line synchronization pulses.

18. Video signal according to any one of claims 15 to 17 inclusive, **characterized** in that said signal during the smoothing period (T_{E0}) exhibits a modulation by a modulation signal whose frequency and amplitude are such that a display apparatus (10) does not, in a reproduced video signal obtained after registration and reproduction of the video signal, detect any line synchronization pulses during the smoothing period (T_{E2}) of the video signal.

19. Video signal according to claim 18, **characterized** in that the amplitude of the modulation signal is smaller than the amplitude of a chrominance subcarrier burst of the output video signal.

20. Video signal according to claim 18 or 19, **characterized** in that the frequency of the modulation signal is between 100 kHz and 20 MHz.

21. Video signal obtained after registration and reproduction of the video signal according to any one of claims 15 to 20 inclusive.

22. Use of an apparatus according to any one of claims 9 to 14 inclusive.

23. Use of a video signal according to any one of claims 15 to 21 inclusive

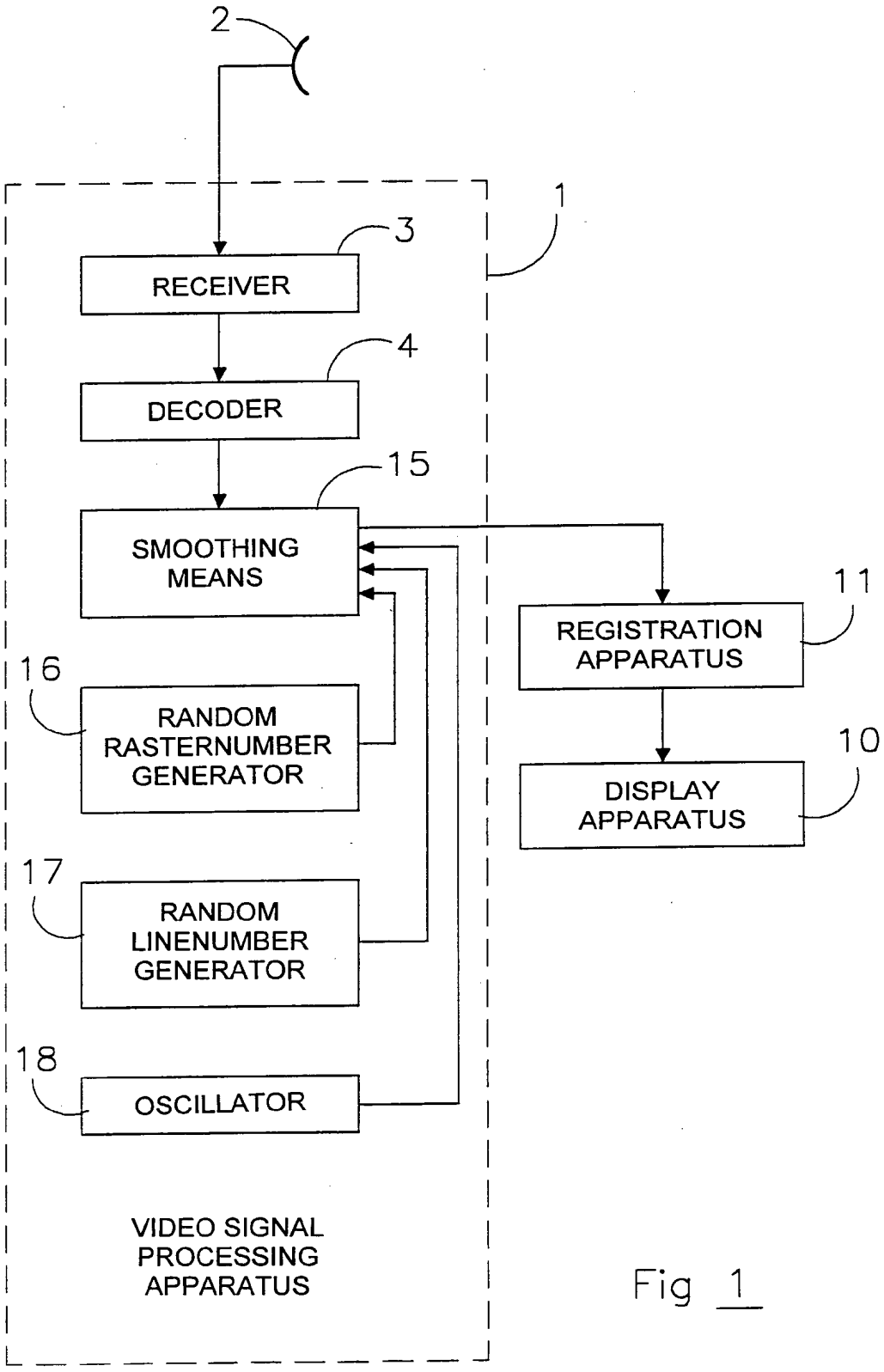
2
1
3
RECEIVER
4
DECODER
15
SMOOTHING MEANS
11
REGISTRATION APPARATUS
16
RANDOM RASTERNUMBER GENERATOR
10
DISPLAY APPARATUS
17
RANDOM LINENUMBER GENERATOR
18
OSCILLATOR
VIDEO SIGNAL PROCESSING APPARATUS

Fig 1

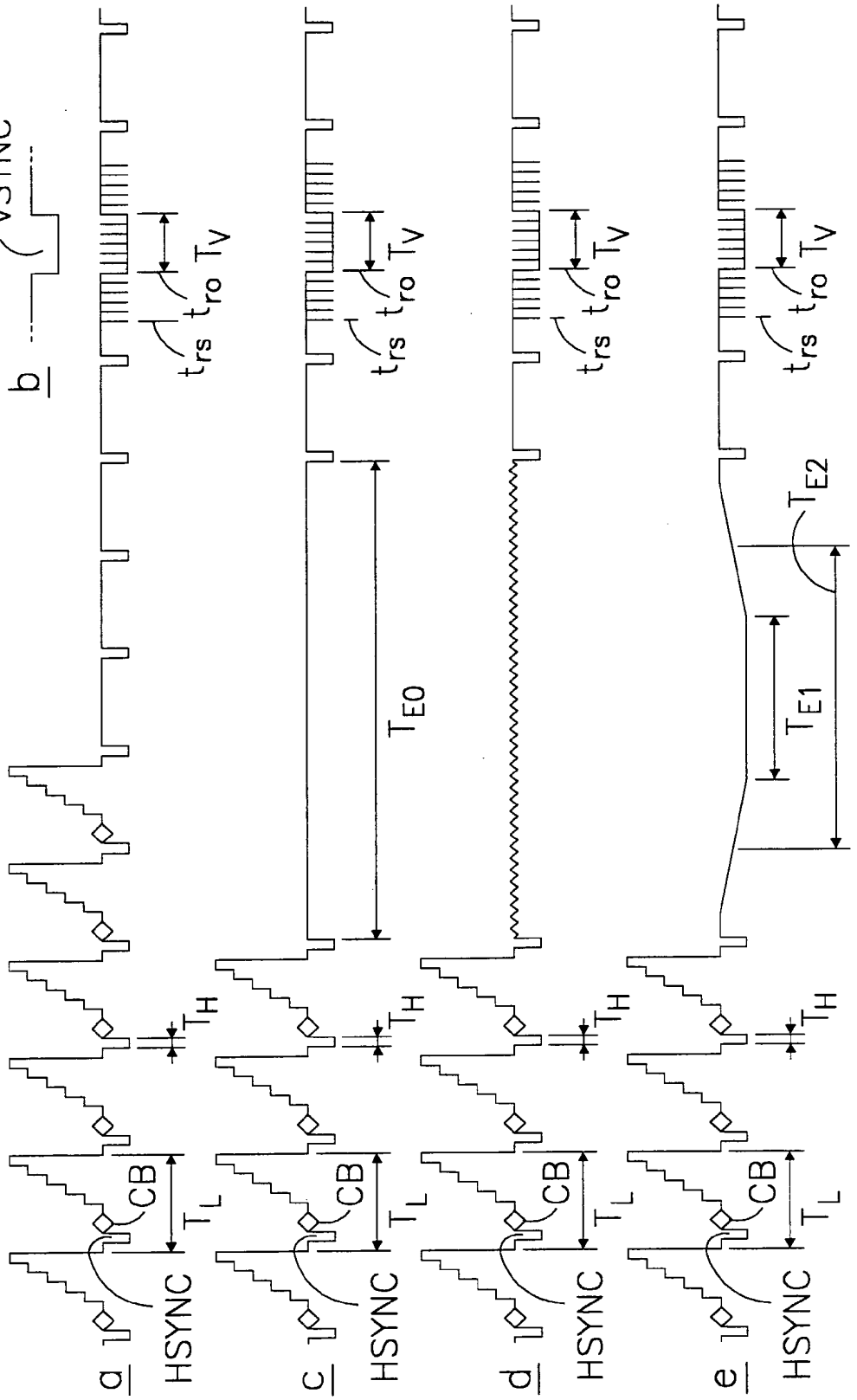

Fig 2

INTERNATIONAL SEARCH REPORT

Ir ıtional Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04N5/913

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 583 936 A (WONFOR ET AL.) 10 December 1996 (1996-12-10) column 10, line 10 -column 12, line 30; figures 5A-5C	1,9,15
A	EP 0 831 648 A (SONY CORPORATION) 25 March 1998 (1998-03-25) column 3, line 20 - line 56; figure 4	1,9,15

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
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Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Verleye, J

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